



2002 Iowa Mathematics and Science Needs Assessment Executive Summary

*A Study of Iowa Teachers,
Superintendents, AEA Mathematics
and Science Coordinators, and Higher
Education Faculty*

Mari Kemis, Tony Heiting, Judith Spitzli, and Evette Lang
May 2003

Research Institute for Studies in Education, Iowa State University
Iowa Department of Education

Support provided by the Iowa Department of Education



**2002 Iowa Mathematics and
Science Needs Assessment**
Copyright©2003 Iowa State University and
Iowa Department of Education

Acknowledgements:

Marva Ruther Ellengray Kennedy
Robyn Johnson Kathy McKee

Research Institute for Studies in Education
E005 Lagomarcino Hall • Iowa State
University • Ames, IA • 50011
Phone: 515-294-7009 • Fax: 515-294-9284
www.educ.iastate.edu/rise/

Iowa Department of Education
Grimes State Office Building
Des Moines, IA • 50319
Phone: 515-281-3249 • Fax: 515-242-6025
www.state.ia.us/educate/

2002 Iowa Mathematics and Science Needs Assessment

A Study of Iowa Teachers, Superintendents, AEA Mathematics and Science Coordinators, and Higher Education Faculty

Executive Summary

The 2002 Iowa Mathematics and Science Needs Assessment is the third in a series of studies examining reform in mathematics and science in Iowa schools. In the past ten years, reform efforts in mathematics and science have included the advent of national standards and subsequent efforts to integrate these standards into curriculum and implement them in classrooms, many and varied opportunities for professional development of teachers so that they can teach to the standards, and shortages of teachers in both subject areas. Recent state (HF2272) and federal legislation (*No Child Left Behind*) raise new concerns about learning and teaching in mathematics and science, requiring educators at all levels to have accurate and credible information as they are making decisions. This 2002 study builds on the results of previous studies in 1992 and 1995 and looks to the future of mathematics and science education in Iowa.

Purpose of the 2002 Iowa Mathematics and Science Needs Assessment

The 2002 Iowa Mathematics and Science Needs Assessment was intended to provide the following:

- Data that indicate progress made in the level of awareness and implementation of national mathematics and science standards.
- Data that can be used by individual school districts to complete their own needs assessments.
- Data that address teacher quality and teacher shortage in mathematics and science.
- Data that can be used in improving teacher preparation programs.
- Data that provide information that supports applications for grants, such as mathematics and science partnerships.

In addition, the results of this study will assist school districts, Area Education Agencies (AEAs), higher education institutions, and the Iowa Department of Education in setting direction and focus in mathematics and science education that is aligned with legislative requirements and meets the needs of Iowa's school districts.

Methodology

The Iowa Department of Education, in conjunction with the Research Institute for Studies in Education (RISE), College of Education at Iowa State University, conducted the 2002 Iowa Mathematics and Science Needs Assessment. The 2002 study was conducted by mail survey during September and October 2002. Survey participants included 1132 Iowa teachers, superintendents, AEA mathematics and science coordinators, and selected higher education mathematics and science education faculty. Responses to these surveys were received from 49% of the teachers, 83% of the superintendents, 93% of the AEA mathematics and science coordinators, and 80% of the higher education mathematics and science faculty surveyed.

Results

The results of the 2002 Iowa Mathematics and Science Needs Assessment contain information for several topic areas that represent state or national initiatives. A summary of the key findings in each of these topic areas follows.

- Teacher preparation and licensure
- Improving mathematics and science
- Teacher professional development
- Implementing reform in K-12 classrooms in Iowa
- Integrating environmental education
- Assessment
- Use of technology
- AEA issues
- Teacher supply and demand
- Partnerships
- National initiatives – No Child Left Behind

Teacher Preparation and Licensure

Preparing teachers to have an understanding and working knowledge of the content and standards in mathematics and science is important in providing quality education. Teachers and higher education faculty responded to questions related to teacher preparation and licensure.

For the most part, teachers reported that they are well prepared to teach mathematics and science, particularly at the middle and high school levels. While elementary teachers were confident in their preparation to teach mathematics and science, many secondary mathematics and science teachers disagreed that elementary teachers are adequately prepared. Teachers also reported that, in general, they were well prepared to integrate technology and environmental education into their teaching.

Like the teachers, faculty respondents were positive about the preparation of mathematics education majors at the secondary level. About two-thirds of them indicated that their institutions adequately prepared elementary education majors to teach mathematics and science. College and university science faculty reported that their institutions adequately prepared secondary science majors. They also thought that they were adequately addressing mathematics and science standards in their teacher preparation programs. A marked difference was evident between mathematics and science programs in the amount of time students spend in practicum experiences prior to student teaching. Most mathematics students spend up to eight weeks in practicum experiences, while over half of the science students spend more than 15 weeks.

Higher education mathematics and science faculty were split when asked whether their programs would grow stronger over the next five years. Faculty respondents wrote that positive changes in programs would likely be attributed to curricular improvements, increased student interest, committed and well qualified faculty, a new licensure program, a continual process of evaluation and improvement, and a willingness to change and adapt. Lack of funding, loss of faculty, and lack of support from college and university administration were cited as reasons for weakening programs.

Teachers generally thought that the current requirements for licensure in mathematics were sufficient for elementary, middle school, and high school teachers. One exception was that only 22% of the secondary mathematics teachers thought that the requirements were sufficient for elementary teachers and recommended that elementary pre-service teachers need better foundations in mathematics, more methods classes, and experiences in real classrooms. Unlike teachers, few faculty at Iowa's colleges and universities thought licensure requirements were sufficient at any level. Faculty respondents made similar recommendations to address insufficient licensure requirements.

Teachers and higher education faculty respondents gave similar responses about the sufficiency of licensure requirements in science for elementary, middle school, and high school teachers. Like for mathematics, they suggested that a broader science background with more content knowledge and science methods courses, as well as classroom experiences, would address insufficient licensure requirements.

Improving Mathematics and Science

Teachers and superintendents, and AEA coordinators offered opinions about improving mathematics and science education and examined areas of need, possible strategies that could be used, and key issues related to teacher quality, recruitment, and retention.

Teachers and superintendents agreed that leadership or assistance from teachers, building administrators, and the AEAs, as well as quality instructional materials, were adequate and important in improving mathematics and science. Other factors that were seen as important by both teachers and superintendents included (1) opportunities for teachers to share ideas and strategies with their peers, reflect on their own teaching, and participate in teacher inservice activities in mathematics and science; (2) a sufficient level of funding for science and mathematics; (3) teachers' awareness of the uses of, as well as their skills in utilizing, appropriate instructional technology in mathematics and science and the availability of appropriate instructional technology in the classroom for teaching mathematics and science; and (4) knowledge about reform efforts.

Areas of need, where importance was high but adequacy was low, were also examined. Teachers reported that funding for mathematics and science, leadership or assistance from universities and the Iowa Department of Education, and articulation between levels in both mathematics and science were areas of need in 2002. Elementary teachers also saw a need for appropriate instructional technology and improved skills in using technology in the

classroom for teaching mathematics and science. Further, areas of need in improving mathematics and science noted by secondary mathematics and science teachers included parent, community, and business involvement in reform efforts and opportunities for teacher inservice activities.

In a comparison with the results from 1992, fewer areas of need were reported in 2002, a result of teachers reporting increased adequacy for these topics. Areas of need listed in 1992, but no longer listed in 2002, include level of funding (elementary teachers), leadership from counselors or curriculum supervisors (secondary science teachers), communication among educators, parents, community members, and business leaders (secondary mathematics teachers), involvement of parents, community members, and business leaders in reform efforts (elementary teachers), opportunities for teachers to share ideas and strategies with peers (secondary science teachers), use of multiple assessment measures (secondary mathematics and science teachers), and availability of appropriate instructional technology (secondary mathematics and science teachers).

From a list of possible strategies for improving mathematics and science education, teachers agreed that additional funding for equipment, facilities, and staff was needed. They also indicated that teachers need more opportunities to participate in inservice activities in their subject areas. Other key strategies seen as important for improving mathematics and science included increasing instructional time in mathematics and science at the elementary level, requiring elementary teachers to take more mathematics and science courses at the undergraduate level, and forming partnerships with universities and the private sector.

The quality of teachers, attracting them to the profession, and retaining them are seen as key in improving mathematics and science education in Iowa. Teachers, superintendents, and AEA coordinators saw five issues related to recruiting and retaining quality teachers — (1) salary and funding, (2) content

knowledge and teaching strategies, (3) resources, (4) environment, government relations, and support, and (5) the unique challenges of rural and small school districts. They wrote about adequate pay, funding for salaries, and incentives for those teaching mathematics and science. They addressed the need for increased content knowledge, sound pedagogy, professional development, strong undergraduate training and teacher preparation, the use of multiple teaching strategies and effective teaching methods, and the incorporation of standards and benchmarks. They voiced concerns about (1) the need for appropriate equipment, (2) lack of time, and (3) heavy workload. They addressed support from mentors; the need for increased collaboration; classroom management and safe environments; teacher retirement and attrition; certification and licensure requirements; government guidelines and increased paperwork; and support of administrators, parents, and legislators. Finally, they wrote about lack of incentives to keep quality teachers in Iowa's rural and smaller schools.

Teacher Professional Development

The continuing professional development of Iowa's teachers is essential to retaining quality teachers. Teacher professional development needs were reported as generally met in 2002, as they were in 1992. However, selected areas of need for professional development remain.

Teachers agreed that they were adequately prepared in content knowledge in mathematics and science, planning and delivering instruction, selecting and organizing materials, organizing classroom learning opportunities, and understanding and managing behavior problems in the classroom. In contrast to their responses to a similar question where teachers felt that they had been well prepared in their teacher preparation programs, they noted that they were not as well prepared to incorporate environmental education and use instructional technology in the classroom when considering professional development.

Several of these areas and others were mentioned as important – understanding and managing behavior problems in the classroom, selecting and organizing materials, working with students with learning problems, making accommodations for students with special needs, organizing classroom learning opportunities, using instructional technology in the classroom, utilizing multiple assessments, and using instructional strategies such as cooperative learning and peer coaching.

Despite adequate preparation in many areas, professional development needs were evident for teachers. Seventy to eighty percent of elementary teachers and a majority of secondary mathematics and science teachers agreed that they need more opportunities for professional development in content knowledge and incorporating standards. More than half of the teachers reported their need for professional development or inservice training in specific areas – using instructional technology in teaching mathematics and science, working with students with learning problems, using multiple assessments, using strategies to meet the needs of underrepresented groups in mathematics and science, using environmental education strategies to enhance the curriculum, aligning curriculum standards and benchmarks with assessment, using the Iowa Communications Network (ICN), and using instructional strategies such as cooperative learning and peer coaching.

To provide opportunities for professional development for mathematics and science teachers, superintendents planned to set aside funds from the Title II allocation for 2002-2003. They anticipated using the funds for a variety of activities, including aligning standards and benchmarks with assessments, teacher participation in workshops or mathematics and science conferences, working with AEA coordinators, paying for teacher collaborations, funding mentoring programs, and enhancing content background in mathematics and science.

The AEAs and higher education institutions play a key role as partners with local schools by providing professional development activities for teachers. Their suggestions that the Regent's higher education (competitive grant) program for professional development focus on enhancing content, implementing national standards into the curriculum, and incorporating inquiry-based learning in mathematics and science are consistent with needs expressed by teachers. Further, they recommended that emphasis for professional development in mathematics should address learning styles and how they impact mathematics instruction, differentiated instructional strategies, how to use assessment to inform instruction, integrating technology, and keeping a focus on student learning by improving content knowledge and understanding. For science, two primary areas of focus were suggested – programs to help teachers implement inquiry-based instruction and aligning instruction with standards, benchmarks, and assessments.

Finally, teachers, superintendents, AEA coordinators, and higher education faculty suggested the best ways for teachers to learn about mathematics and science reform. There was agreement from all four groups that participating in professional development activities, such as targeted inservices or workshops with hands-on activities, was the best way. Other ways for learning about mathematics and science reform included peer assistance and mentoring, reading research and practitioner publications, attending mathematics and science conferences, and taking graduate level courses.

Implementing Reforms in K-12 Classrooms in Iowa

A key finding of the 2002 Needs Assessment is understanding how reforms in mathematics and science are being implemented in K-12 classrooms in Iowa. Teachers were asked to indicate how effective they have been in incorporating mathematics and science standards in their classrooms, how they talk about and work with their colleagues regarding standards, and how they

incorporate the standards into their teaching. Superintendents and AEA coordinators provided information on how local standards and benchmarks have affected student achievement and instruction, and teachers and superintendents reported about revisions to their curricula. Finally, all respondent groups wrote about effective ways that their educational partners could assist teachers in incorporating reform into their classrooms.

Many of the teachers in 2002 (56%) have incorporated changes in curriculum, instructional methods, and assessment reforms consistent with the recent standards. In 1995, 46% were incorporating reforms. In 2002, they reported that they have been effective in incorporating the standards overall and standards related to instructional methods and curriculum changes, although they thought they have been less effective in incorporating standards related to assessment practices. Overall, teachers in 2002 believed that they are more effective in incorporating the standards in their classrooms than they were in 1995. This was consistent for standards related to instructional methods, curriculum changes, and assessment, as well as overall.

While most teachers do not necessarily talk with their peers or administrators about reforms in mathematics and science, they have increased their communication about it over the past seven years. About 40% of teachers in 2002 talked to teachers in their own district about reform at least monthly, an increase from 28% in 1995.

Most teachers reported that they had participated in inservice training related to mathematics and science reform. About one-third noted a total of two to five days of training and an additional 10% of all teachers had at least three weeks of inservice training. Further, most are applying what they have learned in these inservices in their classrooms. There was little difference in the amount of inservice training received by teachers from 1992 to 2002.

Teachers described their familiarity with the standards and reported on recent curriculum revisions in their districts. Consistent since 1995, most

elementary and secondary mathematics teachers in 2002 were familiar with mathematics standards at their own level. Not surprisingly, they were not as familiar with the standards at the other levels. Science teachers reported similar results. Only about one-third of elementary teachers were familiar with the science standards, although over 70% of secondary science teachers were familiar with the standards. Again, they were even less familiar with the standards at the other grade levels.

Most teachers indicated that the mathematics curriculum in their district was revised within the last two years, was currently under revision, or would be revised within the next two years. About half of them reported that the mathematics standards had been incorporated extensively into recent curriculum revisions and almost all of these teachers indicated that they would be incorporated extensively in the next revision. As expected, the NCTM standards have been increasingly incorporated into district mathematics curriculum revisions since 1992. There were some changes in teacher attitude in 2002 about district policy for adhering to the mathematics curriculum as required. There was a slight shift, with a larger percentage of teachers recognizing the curriculum as required. Fifteen percent of secondary mathematics teachers continue to think of it as voluntary.

Like mathematics, most science curricula have been recently revised or will be revised in the next two years. The science standards currently do not appear to be as extensively incorporated into the curriculum revisions as are the mathematics standards, but those with science curriculum revisions underway or expected plan to incorporate science standards extensively. About half of elementary and secondary science teachers think that they are required to adhere to the science curriculum, up from about 25% in 1995.

In 2002, curriculum revisions are most often underway or expected in the next two years in the smallest districts in Iowa. Larger districts have more often

recently completed their revisions and do not expect to make revisions for another five years.

Mathematics and science teachers have strong opinions about reform in their subject areas. About 40% of secondary teachers agree that they are well prepared to implement the standards in their classrooms, while one-fourth to one-third of the elementary teachers disagreed that they are prepared. Most mathematics teachers thought that they were prepared to address the Iowa teaching standards and the NCTM standards. Secondary science teachers felt prepared to address the NSES standards and that they had adequate preparation to teach science subjects. Many elementary teachers noted the need for better preparation to teach to the standards, address closing the achievement gap, and address special needs of students. Despite their preparation and willingness to implement the standards in their classrooms, only about one in four teachers agreed or strongly agreed that reforms in mathematics and science have had a positive impact on student learning, a less positive response than in 1995.

Like teachers, a majority of superintendents were familiar with standards for mathematics and science. However, about one-fourth to one-third of the superintendents indicated little or no knowledge of the standards. They also reported that curriculum revisions in both mathematics and science most often had been made within the last four years. The revisions were guided by current trends and best practices and resulted in incorporating standards and benchmarks. A higher percentage of superintendents (75%) than teachers (about 50%) reported that adhering to the established curriculum was required.

About 60% of the superintendents reported that their districts had added mathematics courses during the last five years, staffing them through reassignment of current teachers or by having teachers teach additional periods or subjects. Forty-five percent of the superintendents reported adding science courses, again staffing them through reassignment or adding additional periods or subjects.

Superintendents and AEA coordinators reported that local standards and benchmarks have had a positive effect on both student achievement and instruction in mathematics and science. Many teachers commented that standards and benchmarks have helped them focus their teaching, made them more accountable in assessing their students, and helped them to implement a consistent curriculum with other teachers at their grade level. Conversely, a few teachers have noticed little or no effect on their teaching, citing that the implementation of the standards and benchmarks was time consuming or encourages them to teach to tests.

Finally, there was agreement from teachers, superintendents, AEA coordinators, and higher education faculty on how the Iowa Department of Education, the AEAs, local school districts, and higher education institutions can assist teachers in incorporating mathematics and science reform into their classrooms. They suggested that providing effective and long-term professional development opportunities, providing funding for resources like substitutes, materials, technology, and mentoring programs so teachers can learn and practice reforms, more clearly defining standards, and increasing and enhancing communication and interaction with higher education institutions and AEAs would be the best ways to assist teachers.

Integrating Environmental Education

Much of the environmental education occurring in Iowa is driven by the interests of individual teachers. Despite state mandates, there are few requirements and little continuity in schools or districts or across the state. Integrating environmental education is seen to be an effective method to improve student interest and achievement.

Most of the superintendents reported that environmental education had been incorporated into the curriculum, and many thought it was an important or very important component of the curriculum. Most teachers reported that they

spend some time on environmental education during the year, with one in five science teachers spending more than 10% on environmental topics. Whether this was a sufficient amount of time, teachers were split, with slightly over half indicating that it was sufficient and slightly less than half saying that it was not. Teachers also thought that professional development in incorporating environmental education into the curriculum was important, but fewer than half thought it had been adequate.

Science teachers, superintendents, AEA coordinators, and higher education faculty suggested that the Iowa Department of Education could assist them in integrating environmental education by addressing the need for materials, resources, and training; funding programs and professional development; providing information on how to integrate environmental education into other required curriculum; and developing standards and benchmarks for environmental education.

Assessment

State legislation requires that multiple assessments be used in mathematics and science, in addition to using the Iowa Test of Basic Skills (ITBS) and/or the Iowa Test of Educational Development (ITED). For mathematics, a majority of teachers and about half of the superintendents reported the use of performance assessments or a combination of selected response and performance assessments as the format of their multiple assessments. Assessments most often mentioned for mathematics included the Iowa Collaborative Assessment Modules (ICAM), Mid-Iowa Achievement Level Tests, district- and AEA-developed assessments, the New Standards Reference Exam, and NWEA.

For science, a majority of teachers and half of the superintendents reported that they use performance assessments or a combination of selected response and performance assessments as the format of their multiple assessments. Assessments most often mentioned for science included the Mid-

Iowa Achievement Level Tests, PLAN/ACT, district-developed assessments, NWEA, and SCASS performance assessments.

Use of Technology

The use of technology in the classroom has increased since 1992. In 2002, 88% of teachers indicated that they use electronic communication such as email or the internet daily. However, they are not providing opportunities for their students to use it at that same rate. Although student use has increased in the last ten years, over half use it only a few times a year or never with their students.

The frequency of use of the ICN by teachers has also increased since 1995, with double the percentage of teachers using it for professional development in 2002. About one in four teachers used the ICN to provide instructional activities for their students in 2002, twice as many as in 1995. Further, teachers in smaller districts are using the ICN more than teachers in larger districts, both for professional development activities and to provide instructional activities for their students.

In 2002, teachers recognized the importance of integrating instructional technology into mathematics and science classrooms. Forty percent of the teachers indicated that they are well prepared to integrate technology in teaching mathematics and science, and another third somewhat agreed that they are well prepared. Despite this, 13% of elementary teachers, 8% of secondary mathematics teachers, and 10% of secondary science teachers indicated a very high need for professional development in using instructional technology in teaching mathematics and science. In 1992, all groups of teachers (elementary, secondary mathematics, and secondary science teachers) reported that appropriate instructional technology was needed in the classroom for teaching mathematics and science, while, in 2002, only elementary teachers reported this need.

AEA Issues

The challenges that AEAs face, such as loss of funding and reorganization, affect the services and programs they can offer and deliver. AEA coordinators reported that they are concerned about the loss of the Eisenhower money and thought it would negatively affect the programs they provide. Over half of them were unsure how their positions would be affected with AEA mergers, but generally anticipated that they would have additional responsibilities and would likely serve more school districts. Slightly more than half of them anticipated forming a mathematics/science consortium using new Title II funding from the districts.

The AEA coordinators suggested ways that they could work together with the Iowa Department of Education to improve mathematics and science education, including (1) coordinating statewide efforts to provide leadership in establishing collaborative goals with appropriate strategies and monitoring, (2) coordinating inservice training across the state in areas of focus, (3) supporting effective models, and (4) providing effective communication between the Department and the AEAs through sharing information at meetings and cooperative learning about effective programs, research-based instructional strategies, and recent legislation.

Teacher Supply and Demand

Over 300 superintendents provided key information about current supply and demand for mathematics and science teachers in Iowa. They anticipated hiring 509 science teachers and 539 mathematics teachers at the high school level in the next five years. Most of the new teachers will be hired to teach a combination of mathematics or science subjects. In specific subject areas, superintendents expected to hire most of the teachers for algebra, geometry, biology, chemistry, and physics. A high percentage of superintendents, more than 70%, anticipated much or a great deal of difficulty in hiring teachers for

calculus, pre-calculus, trigonometry, statistics and probability, and a combination of mathematics subjects. A similar percentage of superintendents expected to have difficulty in hiring teachers for physics, chemistry, physical science, and a combination of science subjects at the high school level. Superintendents in 2002 expected to have more difficulty in hiring qualified high school teachers in both mathematics and science than they did in 1992.

At the middle school level, superintendents anticipated hiring 220 mathematics teachers and 249 science teachers in the next five years. Again, most of these positions will be filled with teachers who will teach a combination of mathematics or science subjects. About half of the superintendents expected to have much to a great deal of difficulty in hiring mathematics and science teachers at the middle school level. Consistent with the high school level, superintendents in 2002 also expected more difficulty in hiring middle school mathematics and science teachers than they did in 1992.

About 1550 available elementary teaching positions are expected in the next five years. Unlike at the secondary level, superintendents in 2002 anticipated little difficulty in filling these elementary positions.

According to the superintendents, three of four anticipated vacancies at elementary and secondary levels in both mathematics and science will be due to teacher retirements or teachers obtaining a teaching position in another district.

About half of the superintendents indicated that reform movements in mathematics and science have had little or no effect on their hiring practices. For those responding that the reform movements had affected hiring practices, several superintendents noted that they had revised their interviewing and screening processes to incorporate questions about reform, hiring teachers with experience and knowledge of standards, and changing their curricula to reflect the standards. This was consistent with superintendent responses in 1992.

Partnerships

Local school districts partner with the Iowa Department of Education, the AEAs, and Iowa's higher education institutions to enhance mathematics and science education and employ strategies to address statewide initiatives. As one of these strategies, the roles of higher education institutions and the AEAs are seen as important by all groups in providing inservice opportunities to teachers. Teachers, superintendents, and AEA coordinators also agreed that the role of Iowa Mathematics-Science Coalition should be that of (1) serving as a clearinghouse of information and offering inservice to mathematics and science teachers on current practices and strategies, (2) providing leadership by lobbying for increased funding for education and encouraging entry into and retention in teaching mathematics and science, and (3) developing standards and assessments in mathematics and science.

Additionally, respondents considered that collaborations like the Regents Academy for Mathematics and Science (RAMS) and the Governor's Conference for Mathematics and Science Reform are beneficial. A high percentage of key educational partners, particularly the higher education faculty, indicated that they were willing to take leadership roles in seeking grant opportunities in mathematics and science.

National Initiatives – No Child Left Behind

The No Child Left Behind legislation is already having a widespread impact on mathematics and science education in Iowa. About half of the elementary and secondary mathematics teachers, superintendents, and AEA coordinators, one-third of the secondary science teachers, and over half of the higher education faculty reported that they have an adequate understanding of the law. A lesser percentage in each group indicated that they understood the law's implications for mathematics and science education.

Note: The complete 2002 *Iowa Mathematics and Science Needs Assessment* report, with accompanying tables, graphs, and charts, can be viewed and downloaded from the Iowa Department of Education website – www.state.ia.us/educate/